CLAIMS

We claim:

1. A semi-solid composition comprising:

a vasoactive prostaglandin;

a penetration enhancer;

a polymer thickener selected from the group consisting of a polysaccharide gum and a polyacrylic acid polymer;

a lipophilic component that is selected from the group consisting of an aliphatic C_1 to C_8 alcohol, an aliphatic C_8 to C_{30} ester, a liquid polyol and a mixture thereof; water and

a buffer system that provides a buffered pH value for said composition in the range of about 3 to about 7.4.

2. The composition of claim 1 wherein the vasoactive prostaglandin is selected from the group consisting of PGE_1, PGA_1, PGB_1, $PGF_{1\alpha}$, 19-hydroxy-PGA_1, 19-hydroxy-PGB_1, PGE_2, PGA_2, PGB_2, 19-hydroxy-PGA_2, 19-hydroxy-PGB_2, PGE_3, PGF_3, $PGF_{3\alpha}$, a pharmaceutically acceptable salt thereof, a lower alkyl ester thereof and a mixture.

3. The composition of claim 1 wherein the vasoactive prostaglandin is selected from the group consisting of prostaglandin E_1, prostaglandin E_2, a pharmaceutically acceptable salt thereof, a lower alkyl ester thereof and a mixture thereof.

4. The composition of claim 1 wherein the composition has a viscosity of about 5,000 centipoise (cps) to about 20,000 cps.

5. The composition of claim 1 wherein the composition has a viscosity of about 7,000 cps to about 13,000 cps.

6. The composition of claim 1 wherein the polysaccharide gum is a shear-thinning polysaccharide gum.

7. The composition of claim 6 wherein the shear-thinning polysaccharide gum is a galactomannan gum.

8. The composition of claim 6 wherein the shear-thinning polysaccharide gum is a modified galactomannan gum.

9. The composition of claim 8 wherein the modified galactomannan gum is a modified guar gum.

10. The composition of claim 1 wherein the penetration enhancer is selected from the group consisting of an alkyl-(N-substituted amino) alkanoate, an alkyl-2-(N,N-disubstituted amino) alkanoate, an (N-substituted amino) alkanol alkanoate, an (N,N-disubstituted amino) alkanol alkanoate, a pharmaceutically acceptable salt thereof and a mixture thereof.

11. The composition of claim 10 wherein the penetration enhancer is dodecyl 2-(N,N-dimethylamino)-propionate or a pharmaceutically acceptable salt thereof.

12. The composition of claim 1 wherein the lipophilic component comprises at least one aliphatic C_8 to C_{30} ester.

13. The composition of claim 1 wherein the lipophilic component comprises at least one glyceryl ester selected from the group consisting of monoglycerides, diglycerides, triglycerides, and mixtures thereof.

14. The composition of claim 1 wherein the lipophilic component comprises at least one glyceryl ester selected from the group consisting of glyceryl monooleate, triolein, trimyristin, tristearin, and mixtures thereof.

15. The composition of claim 1 wherein the buffer system provides a buffered pH value for said composition in the range of about 3 to about 6.5.

16. The composition of claim 1 wherein the composition further comprises an emulsifier selected from the group consisting of sucrose esters, polyoxyethylene sorbitan esters, long chain alcohols, and glyceryl esters.

17. The composition of claim 16 wherein the emulsifier comprises at least one glyceryl ester selected from the group consisting of glyceryl monooleate, triolein, trimyristin, tristearin, and mixtures thereof.

18. The composition of claim 1 wherein the composition further comprises a fragrance.

19. The composition of claim 1 wherein the composition further comprises up to about 5 percent myrtenol, based on the total weight of the composition.

20. The composition of claim 1 wherein the composition further comprises a preservative.

21. The composition of claim 1 wherein the composition further comprises a topical anesthetic.

22. A method of treating vasospasm in a subject needing such treatment comprising the step of:

applying to the region of the subject's tissue requiring treatment an effective amount of a semi-solid composition, the composition comprising:

a vasoactive prostaglandin;

a penetration enhancer;

a polymer thickener selected from the group consisting of a shear-thinning polysaccharide gum and a shear-thinning polyacrylic acid polymer;

a lipophilic component that is selected from the group consisting of an aliphatic C_1 to C_8 alcohol, an aliphatic C_8 to C_{30} ester, a liquid polyol and a mixture thereof; water and

a buffer system that provides a buffered pH value for said composition in the range of about 3 to about 7.4.

23. The method of claim 22 wherein the tissue is skin.

24. The method of claim 22 wherein the tissue is vascular extima.

25. The method of claim 22 wherein the vasoactive prostaglandin is selected from the group consisting of prostaglandin E_1, prostaglandin E_2, a pharmaceutically acceptable salt thereof, a lower alkyl ester thereof and a mixture thereof.

26. The method of claim 22 wherein the penetration enhancer is selected from the group consisting of an alkyl-(N-substituted amino) alkanoate, an alkyl-2-(N,N-disubstituted amino) alkanoate, an (N-substituted amino) alkanol alkanoate, an (N,N-disubstituted amino) alkanol alkanoate, a pharmaceutically acceptable salt thereof and a mixture thereof.

27. The method of claim 22 wherein the penetration enhancer is dodecyl 2-(N,N-dimethylamino)-propionate or a pharmaceutically acceptable salt thereof.

28. The method of claim 22 wherein the lipophilic component comprises at least one aliphatic C_8 to C_{30} ester.

29. A method of improving microcirculation in a replanted body part in a subject needing such treatment comprising the step of:

applying to the vascular extima of the blood vessels an effective amount of a semi-solid composition comprising a vasoactive prostaglandin;

a penetration enhancer;

a polymer thickener selected from the group consisting of a polysaccharide gum and a polyacrylic acid polymer;

a lipophilic component that is selected from the group consisting of an aliphatic C_1 to C_8 alcohol, an aliphatic C_8 to C_{30} ester, a liquid polyol and a mixture thereof; water and

a buffer system that provides a buffered pH value for said composition in the range of about 3 to about 7.4.

30. The method of claim 29 further comprising the step of applying an effective amount of the semi-solid prostaglandin composition to the skin of the replanted body part and adjacent skin of the body.

31. The method of claim 29 wherein the vasoactive prostaglandin is selected from the group consisting of prostaglandin E_1, prostaglandin E_2, a pharmaceutically acceptable salt thereof, a lower alkyl ester thereof and a mixture thereof.

32. The method of claim 29 wherein the composition has a viscosity of about 5,000 centipoise (cps) to about 20,000 cps.

33. The method of claim 29 wherein the composition has a viscosity of about 7,000 cps to about 13,000 cps.

34. The method of claim 29 wherein the polysaccharide gum is a shear-thinning polysaccharide gum.

35. The method of claim 34 wherein the shear-thinning polysaccharide gum is a galactomannan gum.

36. The method of claim 34 wherein the shear-thinning polysaccharide gum is a modified galactomannan gum.

37. The method of claim 36 wherein the modified galactomannan gum is a modified guar gum.

38. The method of claim 29 wherein the penetration enhancer is selected from the group consisting of an alkyl-(N-substituted amino) alkanoate, an alkyl-2-(N,N-disubstituted amino) alkanoate, an (N-substituted amino) alkanol alkanoate, an (N,N-disubstituted amino) alkanol alkanoate, a pharmaceutically acceptable salt thereof and a mixture thereof.

39. The method of claim 29 wherein the penetration enhancer is dodecyl 2-(N,N-dimethylamino)-propionate or a pharmaceutically acceptable salt thereof.

40. The method of claim 29 wherein the lipophilic component comprises at least one aliphatic C_8 to C_{30} ester.

41. The method of claim 29 wherein the polymer thickener is a polyacrylic acid polymer.

42. The method of claim 29 wherein the lipophilic component comprises at least one glyceryl ester selected from the group consisting monoglycerides, diglycerides, triglycerides, and mixtures thereof.

43. The method of claim 29 wherein the lipophilic component comprises at least one glyceryl ester selected from the group consisting of glyceryl monooleate, triolein, trimyristin, tristearin, and mixtures thereof.

44. The method of claim 29 wherein the acidic buffer system provides a buffered pH for the composition in the range of about 3 to about 6.5.

45. The method of claim 29 wherein the composition further comprises an emulsifier selected from the group consisting of sucrose esters, polyoxyethylene sorbitan esters, long chain alcohols, and glyceryl esters.

46. The method of claim 29 wherein the emulsifier comprises at least one glyceryl ester selected from the group consisting of glyceryl monooleate, triolein, trimyristin, tristearin, and mixtures thereof.

47. The method of claim 29 wherein the composition further comprises a fragrance.

48. The method of claim 29 wherein the composition further comprises up to about 5 percent myrtenol, based on the total weight of the composition.

49. The method of claim 29 wherein the composition further comprises a preservative.

50. The method of claim 29 wherein the composition further comprises a topical anesthetic.

51. The method in accordance with claim 1 wherein the composition further comprises a topical anesthetic.

52. A method of improving local microcirculation in a tissue comprising:

applying to the surface of the tissue an effective amount of a semi-solid composition, the composition comprising a vasoactive prostaglandin selected from the group consisting of prostaglandin E_1, prostaglandin E_2, a pharmaceutically acceptable salt thereof, a lower alkyl ester thereof and a mixture thereof;

a penetration enhancer selected from the group consisting of an alkyl (N-substituted amino) ester elected from the group consisting of an alkyl-(N-substituted amino) alkanoate, an alkyl-2-(N,N-disubstituted amino) alkanoate, an (N-substituted amino) alkanol alkanoate, an (N,N-disubstituted amino) alkanol alkanoate, a pharmaceutically acceptable salt thereof and a mixture thereof;

a polymer thickener selected from the group consisting of a polysaccharide gum and a polyacrylic acid polymer;

a lipophilic component that is selected from the group consisting of an aliphatic C_1 to C_8 alcohol, an aliphatic C_8 to C_{30} ester, a liquid polyol and a mixture thereof; water and

a buffer system that provides a buffered pH value for said composition in the range of about 3 to about 7.4.

53. The method of claim 52 further comprising the step of applying the semi-solid composition to the vascular extima of the blood vessels supplying the tissue.

54. The method of claim 52 wherein the surface to which the composition is applied is the surface of the skin.

55. The method of claim 52 wherein the polysaccharide gum is a shear-thinning polysaccharide gum.

56. The method of claim 55 wherein the shear-thinning polysaccharide gum is a galactomannan gum.

57. The method of claim 55 wherein the shear-thinning polysaccharide gum is a modified galactomannan gum.

58. The method of claim 57 wherein the modified galactomannan gum is a modified guar gum.

59. The method of claim 52 wherein the polymer thickener is a polyacrylic acid polymer.

60. The method of claim 52 wherein the penetration enhancer is dodecyl 2-(N,N-dimethylamino)-propionate or a pharmaceutically acceptable salt thereof.

61. The method of claim 52 wherein the lipophilic component comprises at least one aliphatic C_8 to C_{30} ester.

62. A method of preventing reperfusion injury of an affected tissue comprising the steps of:

providing the composition of claim 1; and

applying the composition to the surface of the affected tissue.

63. The method of claim 62 further comprising the step of applying the composition to the vascular extima of blood vessels supplying the affected tissue.

64. The method of claim 62 wherein the normal blood perfusion volume is restored in the affected tissue in no more than ten minutes.